# Addressing Climate Change in the Mediterranean Basin: Some thoughts for the future

**In Climate Change Management. 521-527. 01 Jan 2022 DOI**
**https://link.springer.com/chapter/10.1007/978-3-030-78566-6_25**

**Walter Leal Filho**

[1] International Climate Change Information and Research Programme, Research and Transfer Centre "Sustainable Development and Climate Change Management", Hamburg University of Applied Sciences, Germany & Department of Natural Sciences, Manchester Metropolitan University, Chester Street, Manchester M1 5GD, UK. E-mail: walter.leal2@haw-hamburg.de. ORCID: 0000-0002-3993-8974

**and**

**Evangelos Manolas**

Department of Forestry and Management of the Environment and Natural Resources, School of Agricultural and Forestry Sciences, Democritus University of Thrace, 193 Pantazidou Street, 68200 Orestiada, Greece. E-mail: emanolas@fmenr.duth.gr

## Abstract

This short paper provides some perspectives on climate change adaptation in the Mediterranean basin, paving the way for further initiatives.

**Key-words:** Climate change- Mediterranean- Perspectives - Adaptation -

## Introduction

The Mediterranean Sea is in between three continents: Europe, Asia and Africa. In the West connects with the Atlantic Ocean via the Strait of Gibraltar, in the east with the Red Sea, via the Suez Canal. The size of the Mediterranean Sea is 2.966.000 square Kms. Its maximum length, from Gibraltar to the coastline of Syria is 3.860 kms, while its maximum width is 1.800 kms. Throughout history, a great civilization flourished in the Mediterranean Basin. The cultural richness of the Mediterranean basin is exceptional.

There are important differences among Mediterranean countries. Northern Mediterranean counties are much more developed than southern Mediterranean and Middle East countries. These differences are made worse by rapid population growth in the north Africa and Middle East, which has increased from 105 million in 1960 to 444 million in 2017.

In this complex situation, several new challenges from climate change arise, including warming, droughts, extreme weather events, sea-level rise and ocean acidification. These challenges are related with other environmental issues like pollution and urban

growth (Risks Associated to Climate and Environmental Changes in the Mediterranean Region 2019)

**Climate Change and the Mediterranean Basin**

The Mediterranean Region is warming 20% faster than the global average (To Vima team 2019). Although global temperature has increased by 1.1ºC, in the Mediterranean it has increased by 1.4 ºC. Scientists predict increasing risks in the future. In the next decades we expect increase of heat waves, increase of desertification, reduction of rainfall, significant increase of the intensity and the frequency of extreme weather events, while about 100 million citizens will be affected by the availability of water resources (To Vima team 2019).

The Mediterranean has been impacted by climate change in many different ways. More specifically, the Mediterranean basin has been described as a hotspot for climate change and current predictions indicate an increased warming and drying of the area (Fraga et al., 2021).

Many scientists believe that the increase of temperature in the Mediterranean will always be higher than the average temperature of the planet. Water will become precious in the decades ahead. As a result of climate change big parts of Southern Europe and Northern Africa will face serious water shortages in the future.

Many countries may not know the threats they will face. Although some developed countries in the area take serious action, other countries do much less. Countries in the South and Eastern Mediterranean are less equipped in order to sufficiently address the threats of climate change (Kyriatsoulis 2019).

Mediterranean countries account for around 6% of the world greenhouse emissions. However, the Mediterranean basin offers significant possibilities for the production of energy from renewable sources (UNEP n.d.).

Woetzel et al. (2020) provide a useful analysis of climate change with regard to heat, drought, water stress, wildfires, death rate and health issues. It is worth summarizing their effort: past European heat waves have resulted in deaths. In the EU in total, up to 35,000 deaths were attributed to the heat wave of August 2003 (Bhattacharya 2003). Without appropriate mitigation measures, EU researchers predict that heat related mortality could increase twofold by 2080 (Ciskar et al. 2018). Other items of relevance are as follows.

**Heat.** With warm, dry summers and mild winters, the Mediterranean climate has long favored tourism and the cultivation of valuable crops, in particular wine grapes. However, rising temperatures may disrupt established industries and norms. The temperature in the Mediterranean basin has climbed 1.4 degrees, and the rise is predicted to continue to exceed global rates (Cramer et al. 2018). The number of days with a maximum temperature above 37 degrees will affect the entire Mediterranean region, in particular northern Africa, the Middle East, southern Spain, and Turkey (Mediterranean-1) (EURO-CORDEX 2014).

**Drought.** In Italy, Portugal, Spain, and parts of Greece and Turkey, rainfall from April to September is predicted to decrease by as much as 10 percent by 2030 and 20 percent by 2050. (EURO CORDEX 2014). By 2050, drought conditions could be prevalent for at least six months a year in these countries (Mediterranean-2) (Palmer Drought Severity Index ). These changing temperature and rainfall patterns will change the Mediterranean climate. Scientists have projected Madrid's climate in 2050 will be more like Marrakech's in Morocco today, while in France Marseille's climate will resemble that of Algier in Algeria (Bastin 2019).

**Water stress.** In the Mediterranean many basins could see a decline of approximately 10 percent in water supplies by 2030 and of up to 25 percent by 2050 (Mediterranean-3). Water stress already seriously impacts most countries in the Mediterranean. The countries most affected are Morocco and Libya (Woetzel et al. 2020)

Due to climate conditions, an increased demand for water resources will increase by 4 to 18% until the end of the century, while the increase of the population may lead to escalation of these numbers. To such escalation may also contribute factors such as tourist development, new industries and extension of urban zones (Cramer et al. 2018).

In the decades ahead, more than 250 million people will be deprived of the necessary amounts of water they need. In addition, 10 of the 20 cities in the world which are expected to suffer most are located in the Mediterranean (UNEP n.d.)

**Wildfires.** Temperature and drought conditions in southern Europe in Southern Europe are factors which favor severe wildfires such as the ones that killed 99 people in July 2018 in the popular holiday resort of Mati, in Greece. (The Conversation 2018). In 2017, fire destroyed more than 500,000 hectares of forest in Portugal, over 5 percent of the country's area. The largest fire, in and around the town of Pedrógão Grande, killed 66 people (Turco 2019).

Now, new research in Nature Communications suggests that the summer fire season in Mediterranean Europe is going to get worse. Under the warmest climatic predictions, the area that is currently burned annually would double. One might go as far as to say that 40% more area would be burnt even if the Paris Climate Agreement is respected and warming stays below 1.5°C. (The Conversation 2018)

**Death rate and health issues.** The annual death rate which is due to the increase of the temperature in the European side of the Med will increase by 1,8 and 2,6% by mid-21$^{st}$ century while at the end of the century its increase will fluctuate between 3 and 7%. There is increased danger that transmissive diseases will increase by 2050. For example, by 2050, high danger areas with regard to the western Nile virus will extend further and so will the seasons the virus will be transmitted. (MedECC 2020a)

In terms of excessive flooding, future adaptation trends include prioritizing low-risk action to mitigate the effects of flooding (Benito et al., 2020). This includes more nature-based solution in urban areas to prevent flood effects. These solutions have been used to increased water filtration, surface water retention and evaporation which

decreases flow connectivity over the area and reduces the flooding hazards caused by climate change (Ferreira et al., 2020).

With regard to flood fatalities between 1980 and 2018 the MEditerranean Flood Fatality Database (MEFF DB) reports 1809 fatalities (Vinet et al. 2019).

The majority of fatalities (1242, i.e., 69%) occurred in Turkey (Biricik 1997). After Turkey, Southern France is the second region contributing to the human toll, with 275 fatalities, followed by Greece and Catalonia (Vinet et al. 2019).

Agriculture, pre-dominantly olive farming, is adversely affected due to a mixture of over-cultivation and climate effects. Under future climatic conditions agriculture and olive farming are expected to suffer severe adverse effects in many aspects from water relations to quality attributes (Fraga et al. 2021)

The wine industry is also under pressure. The wine industry is important to many economies, and countries such as France, Italy, and Spain produce about half of the world's wine and 74.1% percent of the wine made in the European Union (European Commission 2017)

The production from traditional winemaking areas could suffer as the Mediterranean climate changes, since grapevines are very sensitive to fluctuations in temperature and rainfall. Also, the quality of both grapes and wine is dependent on the weather (Jones et al. 2005). Higher temperatures most often reduce grape quality by increasing sugar levels and decreasing acidity. Researchers have also predicted a wide range of possible impacts of climate change on grape yields. Some scientists think that the Mediterranean area suitable for viticulture could fall by up to 70 percent but others do not see negative impacts at all. (Hannah et al. 2013).

On the other hand, as the temperature in the region increases, it is also possible that specific grape varieties will no longer grow where they do now, while, at the same time, there will be possibilities to plant new varieties. (Wolkovich et al. 2018). Areas in Italy, Portugal, and Spain which grow grapes could experience great reduction in production or even collapse. (Fraga et al. 2016).

Population pressure in coastal areas continues to increase. In the last 50 years (1965-2015) built areas in a distance of 1 km from the sea doubled. As a result, biodiversity, coastal ecosystems and in particular the protection services provided by nature against floods have been downgraded. According to the Barcelona Protocol on the Management of Coastal Areas countries need to completely prohibit building activities for a distance of at least 100 meters from the sea. In Greece, 7%-9% of the coastline has been built, in Turkey 10%-12%, Italy and Spain 13%-17%, Israel 18-26% while the situation is worse in Lebanon where the percentage is 27%-38%.

**Conclusions and recommendations**

In Mediterranean riparian areas, new adaptation methods are being employed. In order to reduce the effects of climate change, riparian areas are being restored using nature-based solutions. Biobased solutions include soil and water engineering. Furthermore, sustainable management plans are being incorporated into restoration and maintenance.

This includes the development of new databases to store information about hydrology and ecology in the area. This may aid in development of novel adaptation methods specific to the area (Zaimes, 2020).

As here outlined, the effects of climate change are seen directly through heat, drought, storms and floods while indirect effects are seen through changes in food and water availability, air pollution and other climatic stressors. Such phenomena impact the health of people in the region with vulnerable population experiencing more severe effects. Future adaptation plans include more control and surveillance plans. Furthermore, more Health Actions Plans need to be implemented with more cross-border collaboration (Linares et al., 2020).

With regards to olive farming, sustainable crop management was applied which resulted in increased crop production and further decreased the carbon-environmental footprint of production. Such methods have been described as essential for climate change adaptation and can be integrated into the national agricultural and environmental policy. Furthermore, a circular sustainable economy can be established (Michalopoulos et al., 2020).

Short term adaptation plans included managing irrigation and protection against extreme weather. It has been suggested that the uses of kaolin clay may aid in reducing stress against extreme climate events. Long term plans include relocation of crops to more suitable areas. Such methods can be translated to other agricultural sectors (Fraga et al., 2021).

In more recent instances innovative adaptation methods to agricultural problems are being developed. This includes inducing epigenetic changes in the plants that targets specific traits in the plants. This helps to build resilience to extreme weather events. This has been carried out to produce drought resistant crops however, more genes are being assessed for future adaptation. Such methods are more advanced than conventional adaptation methods (Martinelli et al., 2020). Finally, we need climate action which will make the region more resilient to challenges. We need actions which will include renewable sources of energy, integrated management of water resources, sustainable agriculture, fishing, alternative tourism. (MedEEC 2020b).

**References**

Benito, G., Sanchez-Moya, Y., Medialdea, A., Barriendos, M., Calle, M., Rico, M., . . . Machado, M. J. (2020). Extreme floods in small mediterranean catchments: Long-term response to climate variability and change. *Water, 12*(4), 1008. doi:https://doi.org/10.3390/w12041008

Bhattacharya, S. (2003). “The 2003 Europe heat wave caused 35,000 deaths,” New Scientist, October 10.

Biricik, A.S. Flood Disasters in Senirkent (13 July 1995–18,19 July 1996). Marmara Geogr. J. 1997, 1, 9–30.

Ciscar J.C., Feyen L., Ibarreta D., Soria A. (coordination) (2018). Climate Impacts in Europe. Final report of the JRC PESETA III project. European Commission. file:///C:/Users/Owner/AppData/Local/Temp/kjna29427enn_1.pdf

Cramer, W., Guiot, J., Fader, M. *et al.* Climate change and interconnected risks to sustainable development in the Mediterranean. *Nature Clim Change* **8,** 972–980 (2018). https://doi.org/10.1038/s41558-018-0299-2

EURO-CORDEX (2014) Regional climate model (RCM) ensemble. Available at https://euro-cordex.net/060378/index.php.en

Bastin JF, Clark E, Elliott T, Hart S, van den Hoogen J, et al., (2019). "Understanding climate change from a global analysis of city analogues," PLOS ONE, July. 14(10): e0224120. Available: https://doi.org/10.1371/journal.pone.0224120

European Commission (2017). Vineyards in the EU – Statistics. Available: https://ec.europa.eu/eurostat/statistics-explained/pdfscache/58459.pdf

Ferreira, C., Mourato, S., Kašanin-Grubin, M., JD Ferreira, A., Destouni, G., & Kalantari, Z. (2020). Effectiveness of Nature-Based Solutions in Mitigating Flood Hazard in a Mediterranean Peri-Urban Catchment. *Water, 12*(10), 2893. doi:http://doi.org/10.3390/w12102893

Fraga, H., Cortazar-Atauri, I.G., Malheiro, A.C., Santos, J.A. (2016). "Modelling climate change impacts on viticultural yield, phenology and stress conditions in Europe," Global Change Biology, November 2016, Volume 22, Number 11. Available: https://onlinelibrary.wiley.com/doi/abs/10.1111/gcb.13382

Fraga, H., Moriondo, M., Leolini, L., & Santos, J. A. (2021). Mediterranean Olive Orchards under Climate Change: A Review of Future Impacts and Adaptation Strategies. *Agronomy, 11*(1), 56. doi:https://doi.org/10.3390/agronomy11010056

Hannah, L., Roehrdanz, P.R., Ikegami, M., Shepard, A.V. et al. (2013). "Climate change, wine, and conservation," Proceedings of the National Academy of Sciences, April 2013, Volume 110, Number 17; Cornelis van Leeuwen et al., "Why climate change will not dramatically decrease viticultural suitability in main wine-producing areas by 2050," Proceedings of the National Academy of Sciences, August 2013, Volume 110, Number 33. PNAS April 23. 110 (17) 6907-6912; https://doi.org/10.1073/pnas.1210127110

Jones, G.V., White, M.A., Cooper, O.R., Storchmann, K. (2005). Climate Change and Global Wine Quality. Climatic Change, Vol. 73, pp. 319-343. Available: https://link.springer.com/content/pdf/10.1007/s10584-005-4704-2.pdf

Kyriatsoulis, A. (2019). Climate change and its effects on the Mediterranean Basin and Greece. Proto Thema. 13 November. Available: https://www.protothema.gr/world/afieromata/to-idaniko-heimoniatiko-spiti/article/923217/i-klimatiki-allagi-kai-oi-sunepeies-tis-pagosmios-kai-eidikotera-sti-mesogeio-tin-ellada-kai-tin-rodo/

Linares, C., Díaz, J., Negev, M., Martínez, G. S., Debono, R., & Paz, S. (2020). Impacts of climate change on the public health of the Mediterranean Basin population-current situation, projections, preparedness and adaptation. *Environmental research, 182*, 109107. doi:https://doi.org/10.1016/j.envres.2019.109107

Martinelli, F., Ollero, F. J., Giovino, A., Perrone, A., Bekki, A., Sikora, S., . . . Bazzicalupo, M. (2020). Proposed Research for Innovative Solutions for Chickpeas and Beans in a Climate Change Scenario: the Mediterranean Basin. *Sustainability, 12*(4), 1315. doi:https://doi.org/10.3390/su12041315

MedECC (2020a) Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report [Cramer, W., Guiot, J., Marini, K. (eds.)] Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France. Available: https://www.medecc.org/first-mediterranean-assessment-report-mar1/

MedEEC 2020b). First Mediterranean Assessment Report, Summary for Policy Makers 2020. Available: https://www.medecc.org/wp-content/uploads/2020/11/MedECC_MAR1_SPM_ENG.pdf-

Michalopoulos, G., Kasapi, K., Koubouris, G., Psarras, G., Arampatzis, G., Hatzigiannakis, E., . . Malliaraki, S. (2020). Adaptation of Mediterranean olive groves to climate change through sustainable cultivation practices. *Climate, 8*(4), 54. doi:https://doi.org/10.3390/cli8040054

Palmer Drought Severity Index.

Risks Associated to Climate and Environmental Changes in the Mediterranean Region. A preliminary assessment by the MedECC Network Science-policy interface (2019). Available: https://ufmsecretariat.org/wp-content/uploads/ 2019/10/MedECC-Booklet_EN_WEB.pdf

Woetzel, J., Pinner, D., Samandari, H. et al. (2020). A Mediterranean basin without a Mediterranean Climate? McKinsey Global Institute. Available: https://www.mckinsey.com/~/media/mckinsey/business%20functions/sustainability/our%20insights/a%20mediterranean%20basin%20without%20a%20mediterranean%20climate/a-mediterranean-basin-without-a-mediterranean-climate.pdf

The Conversation (2018). Wildfires in Mediterranean Europe will increase by 40% at 1.5°C warming, say scientists. 2 October. Available: https://theconversation.com/wildfires-in-mediterranean-europe-will-increase-by-40-at-1-5-c-warming-say-scientists-104270

To Vima team (2019). SOS for climate Change: Sea-level rise in the Mediterranean might reach two meters. To Vima. 4 November. Available: https://www.tovima.gr/2019/11/04/science/sos-gia-tin-klimatiki-allagi-anodos-tis-stathmis-tis-mesogeiou-eos-2-metra/

Turco, M., Jerez S., Augusto S. (2019). Climate drivers of the 2017 devastating fires in Portugal. Scientific Reports. Vol. **9**, Article number: 13886, Available: https://www.nature.com/articles/s41598-019-50281-2.pdf

United Nations Environment Programme (n.d). Sea-level rise in the Mediterranean Region. Available: https://www.un.org/depts/los//consultative_process/contribution21/22UNEPMAP.pdf

Vinet, F., Bigot, V., Petrucci, O., Papagiannaki, K., Llasat,M.C. et al.. Mapping flood-related mortality in the Mediterranean basin: results from the MEFF v2.0 DB. Water, MDPI, 2019, 11 (10), art. no 2196. Available: https://www.mdpi.com/2073-4441/11/10/2196

Wolkovich, E.M., Cortazar-Atawri, I.G., Morales, C.I. (2018). "From Pinot to Xinomavro in the world's future wine-growing regions," Nature Climate Change, Volume 8, Number 1. DOI: 10.1038/s41558-017-0016-6

Zaimes, G. (2020). Mediterranean Riparian Areas–Climate change implications and recommendations. *Journal of Environmental Biology, 41*(5), 957-965. doi:http://doi.org/10.22438/jeb//41/5/MRN-1454